Climate Change Learning Progressions

Nancy Butler Songer
Professor of Science Education and Learning Technologies
The University of Michigan
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What are Learning Progressions?

- How are they defined?
- What knowledge do they represent?
- What role(s) do they serve?

Learning Progressions Defined

Learning Progressions take a stance about both the nature and the sequence of core content and science practices that students should develop over multiple curricular units and years.

(National Research Council, 2007; Songer, Kelcey and Gotwals, 2009)

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What Knowledge Do They Represent?

Learning Progressions take a stance about both the nature and the sequence of **core content** and **science practices** that students should develop over multiple curricular units and years.

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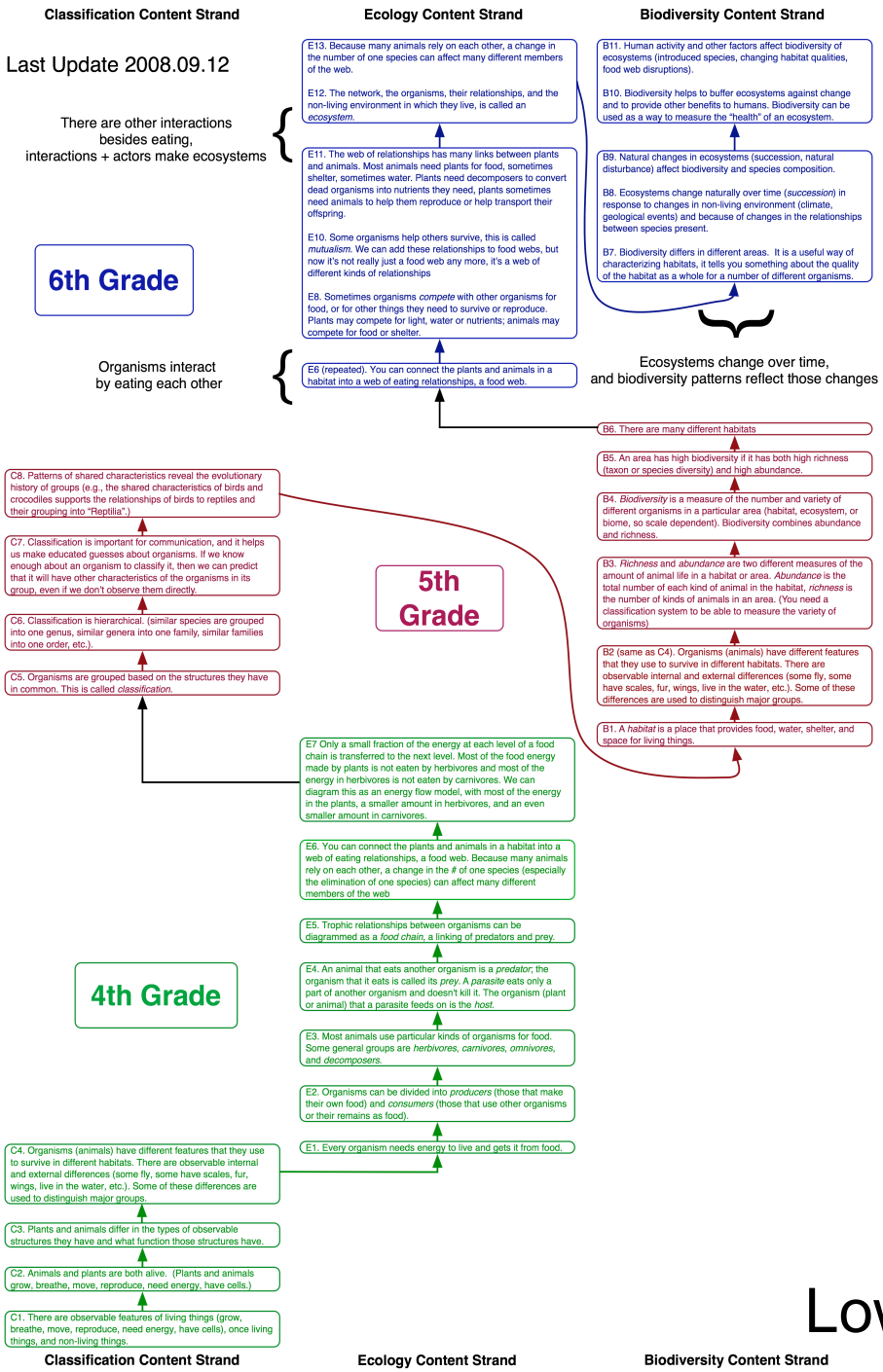


Upper Anchor

2008: Three Year Content Learning Progression in Ecology and Biodiversity

Lower Anchor

Science Practices Emphasized

Students can

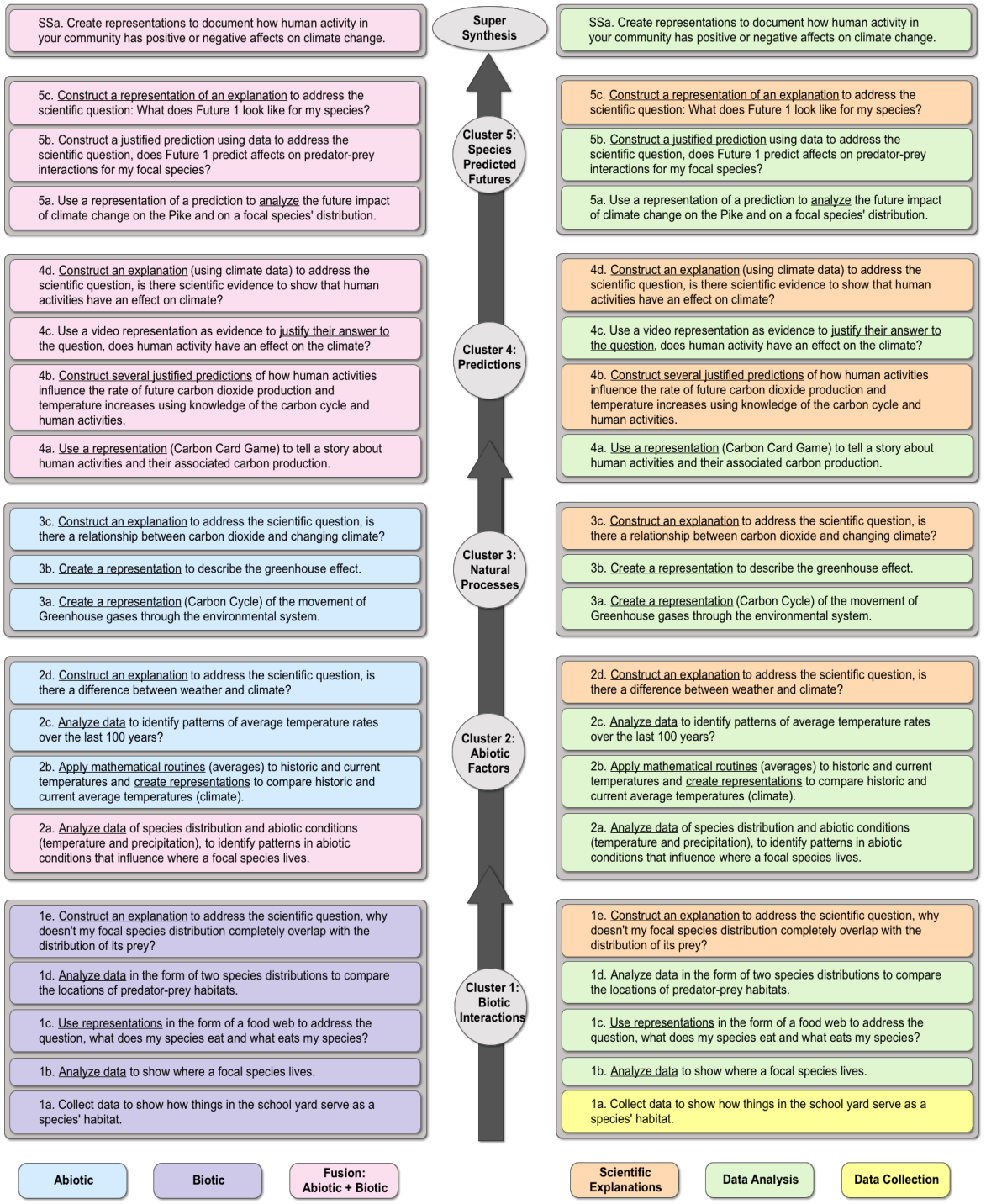
- collect data to answer a particular scientific question
- analyze data to identify patterns or relationships
- construct explanations and predictions

Learning Goals Fuse Content + Practices

- **Content** *Ecology 13:* Because many animals rely on each other, a change in the number of one species can affect different members of the web.
- **Science Practice** *Explanations*: Students build a complete scientific explanation consisting of a claim, two pieces of evidence and reasoning
- **Learning goal**: Students construct scientific explanations to address the question, How have recent changes in the Detroit River affected yellow perch populations?

Middle School Learning Progression, Climate Change Biology

Content Highlighted



Practices Highlighted

Learning Goals Highlighted by Content

3c. Construct an explanation to address the scientific question, is there a relationship between carbon dioxide and changing climate?

3b. Create a representation to describe the greenhouse effect.

3a. Create a representation (Carbon Cycle) of the movement of Greenhouse gases through the environmental system.

Abiotic

Biotic

Fusion: Abiotic + Biotic

Learning Goals Highlighted by Science Practices

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Scientific Explanations

Data Analysis

Data Collection

Cluster 1: Biotic Interactions

1e. Construct an explanation to address the scientific question, why doesn't my focal species distribution completely overlap with the distribution of its prey?

1d. Analyze data in the form of two species distributions to compare the locations of predator-prey habitats.

1c. Use representations in the form of a food web to address the question, what does my species eat and what eats my species?

1b. Analyze data to show where a focal species lives.

1a. Collect data to show how things in the school yard serve as a species' habitat.

Scientific Explanations | **Data Analysis** | **Data Collection**

Cluster 2: Abiotic Factors

2d. Construct an explanation to address the scientific question, is there a difference between weather and climate?

2c. Analyze data to identify patterns of average temperature rates over the last 100 years?

2b. Apply mathematical routines (averages) to historic and current temperatures and create representations to compare historic and current average temperatures (climate).

2a. Analyze data of species distribution and abiotic conditions (temperature and precipitation), to identify patterns in abiotic conditions that influence where a focal species lives.

Scientific Explanations | **Data Analysis** | **Data Collection**

Cluster 3: Natural Processes

3c. Construct an explanation to address the scientific question, is there a relationship between carbon dioxide and changing climate?

3b. Create a representation to describe the greenhouse effect.

3a. Create a representation (Carbon Cycle) of the movement of Greenhouse gases through the environmental system.

Scientific Explanations

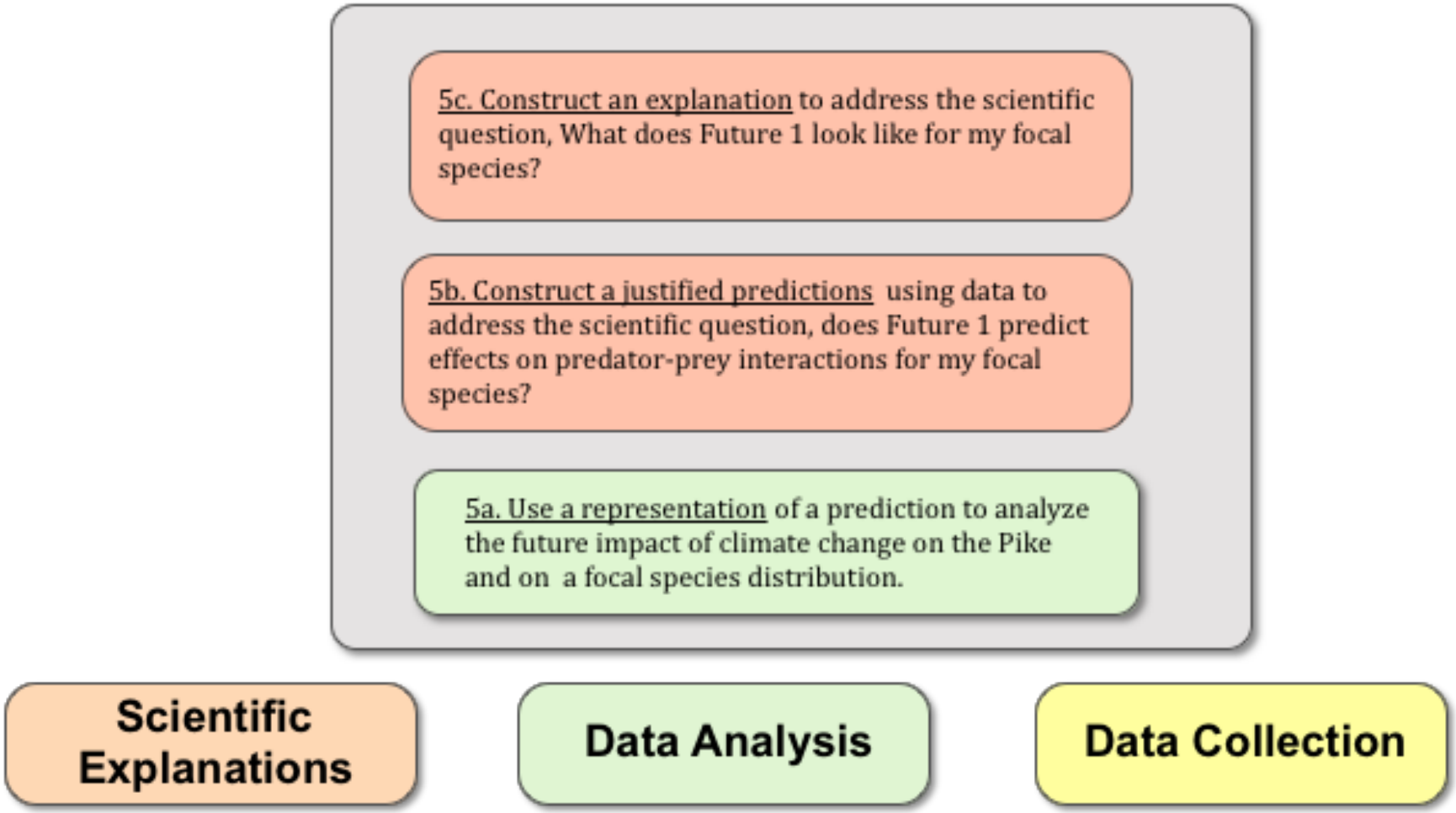
Data Analysis

Data Collection

Learning Progressions
What Roles do they Serve?

Learning Progressions are successively more sophisticated ways of thinking about a topic that **can be used as templates for the development of curricular and assessment products** (Songer, Kelcey and Gotwals, 2009).

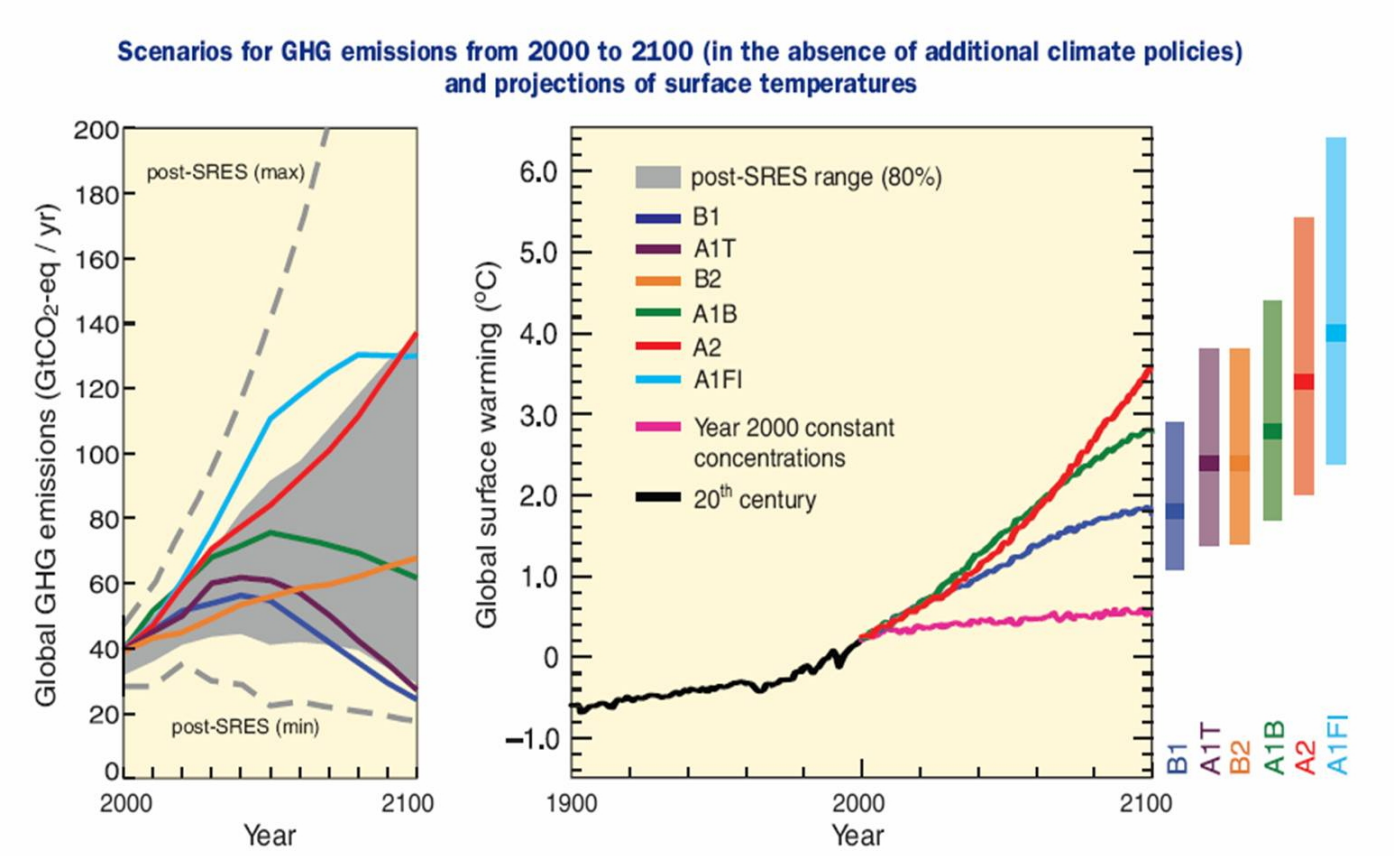
Cluster 5: Species Predicted Futures



Scenarios: Alternative futures (IPCC) = COMPLEX

Future **climate change** depends on future greenhouse gas emissions

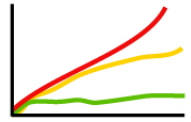
Future **greenhouse gas emissions** depend on socio-economic choices



Strategic Simplication
of Scenarios for Middle Schoolers

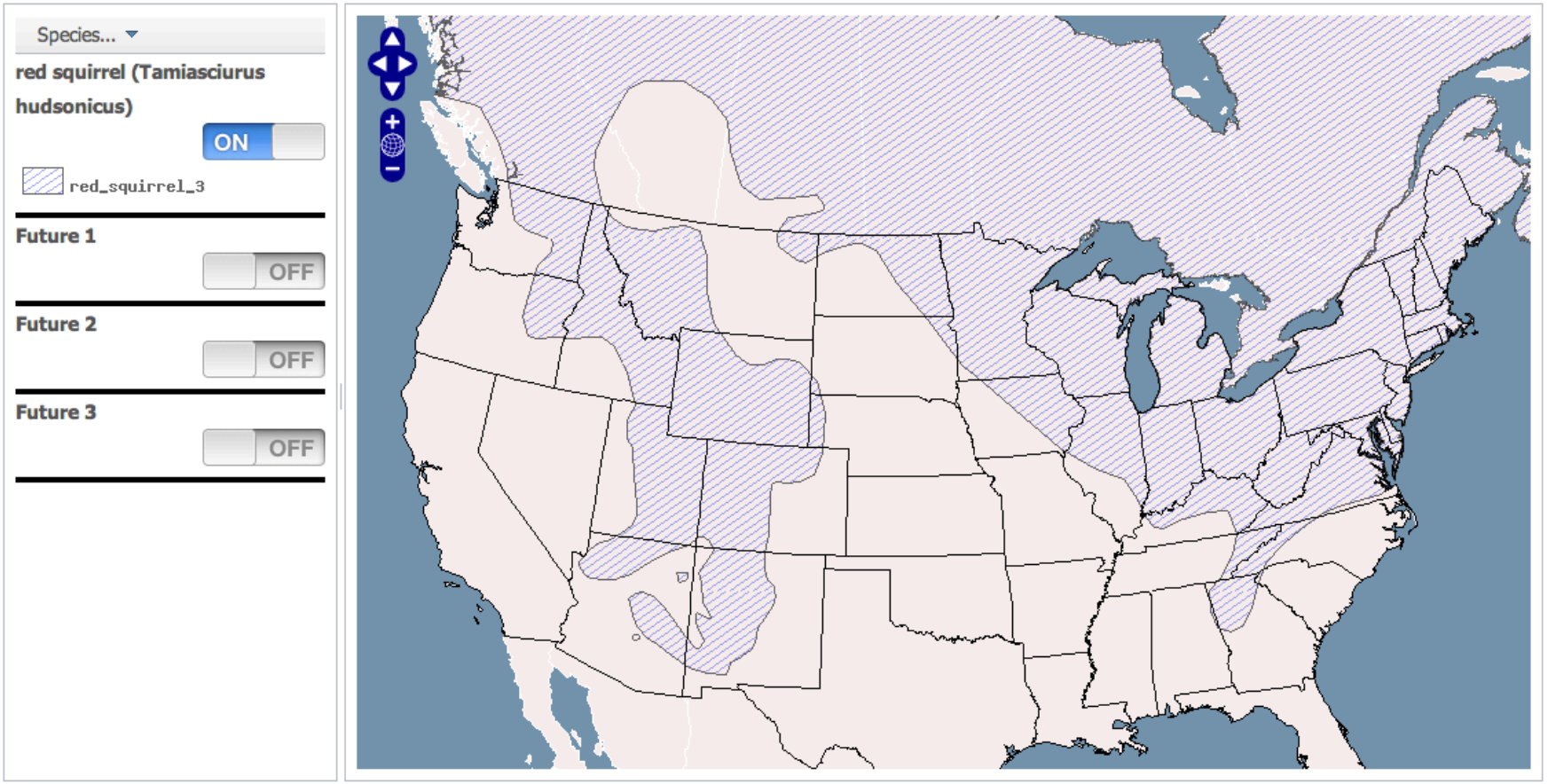
Future **climate change** depends on future greenhouse gas emissions

Future **greenhouse gas emissions** depend on socio-economic choices

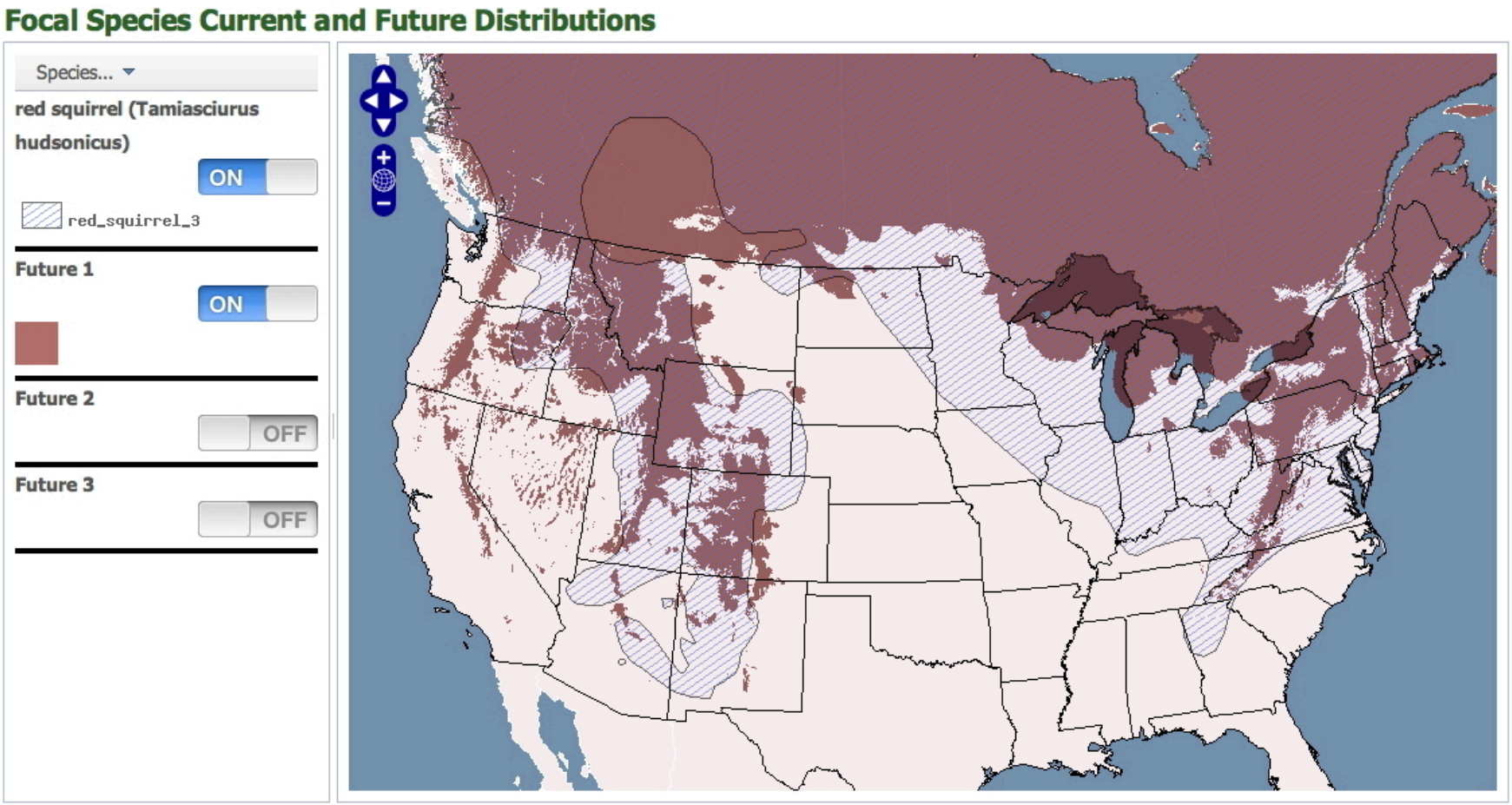
	Population growth rate	Energy use per person	Proportion clean energy	Total CO_2 emissions by 2100 (gigatons)
				
Future 1	Fast	Low	Low	1862
Future 2	Slow	High	High	1499
Future 3	Slow	Low	High	983

Red Squirrel: Current Distribution

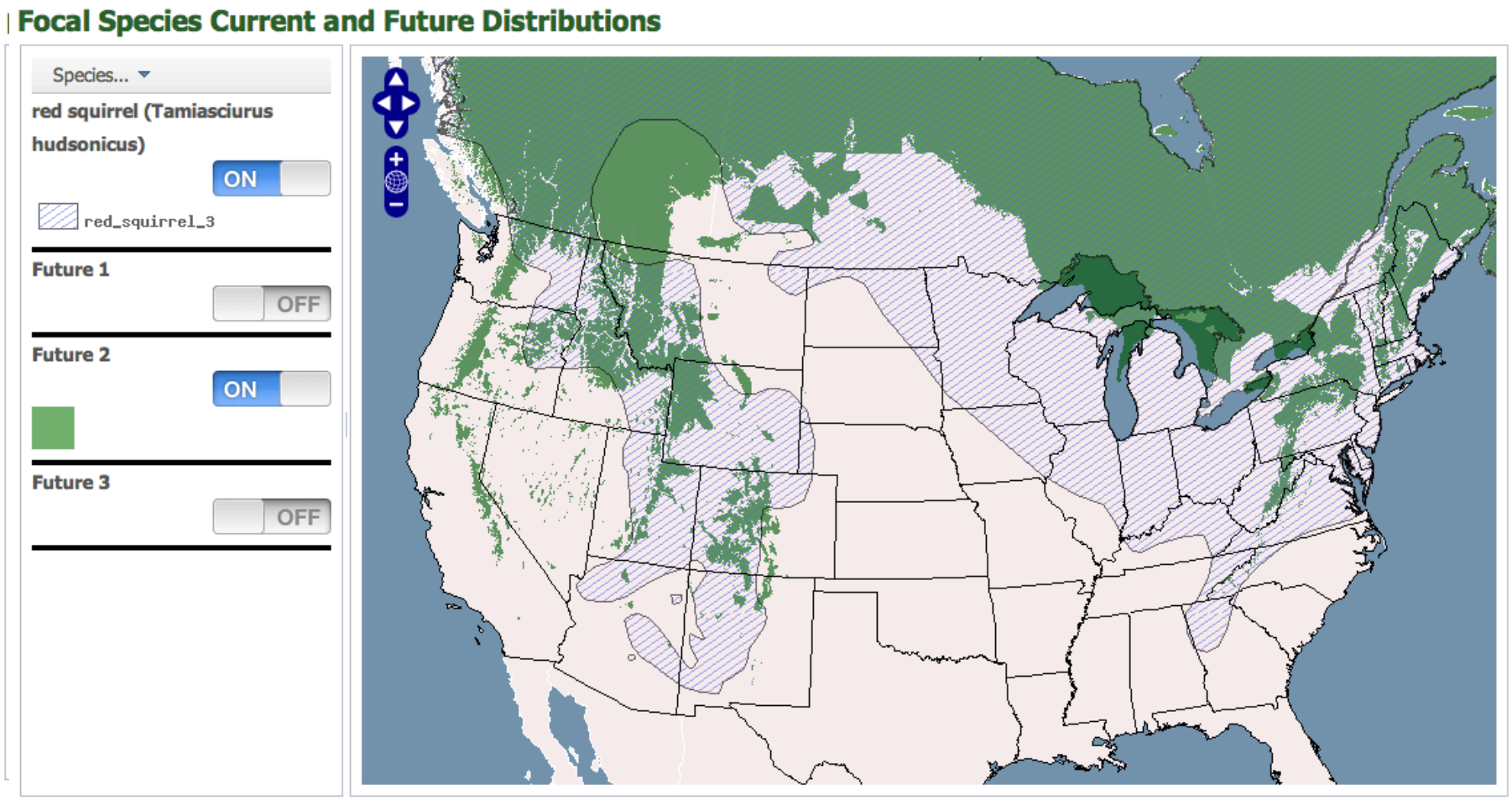
Focal Species Current and Future Distributions



Red Squirrel: Future 1

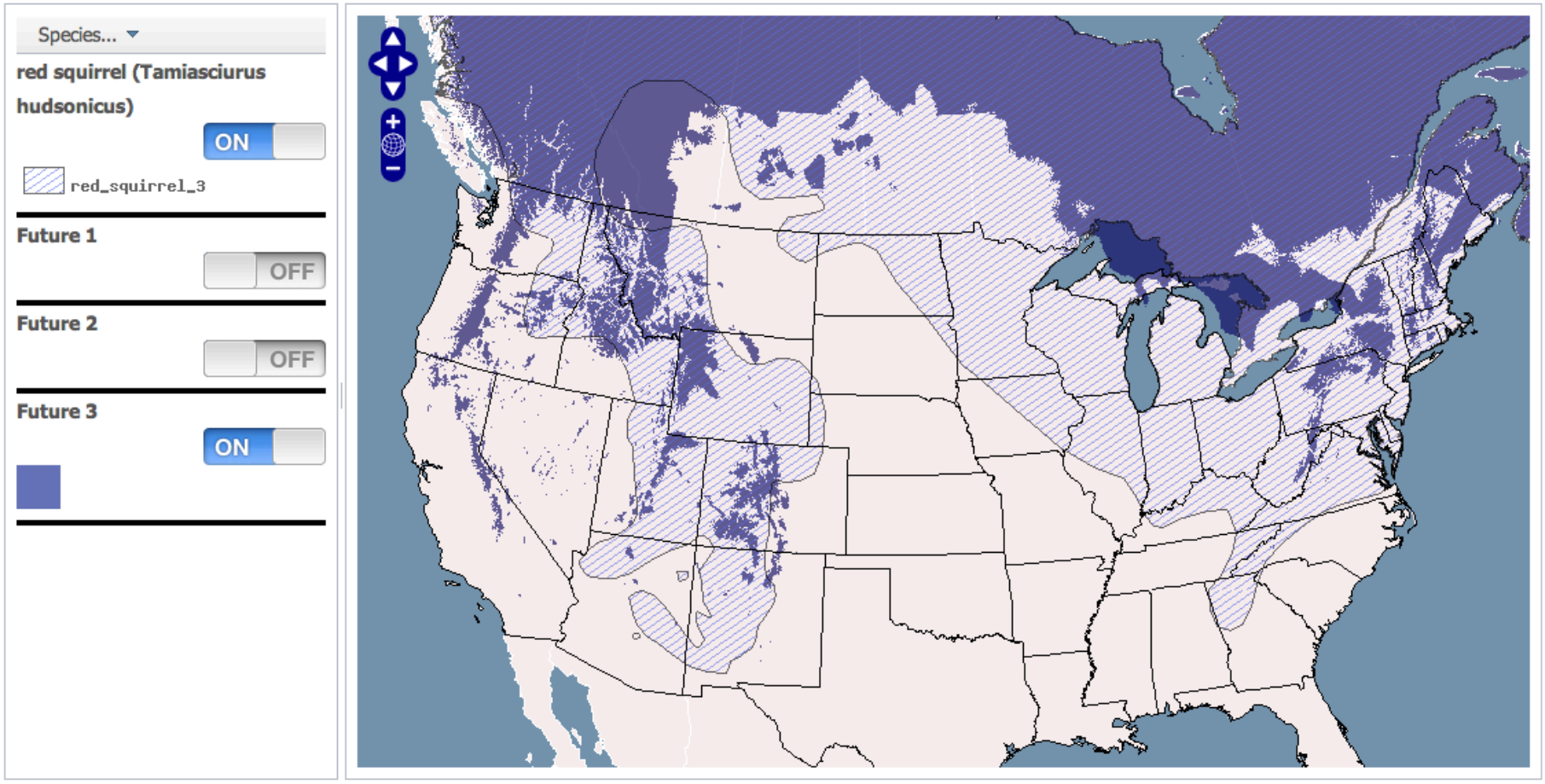


Red Squirrel: Future 2

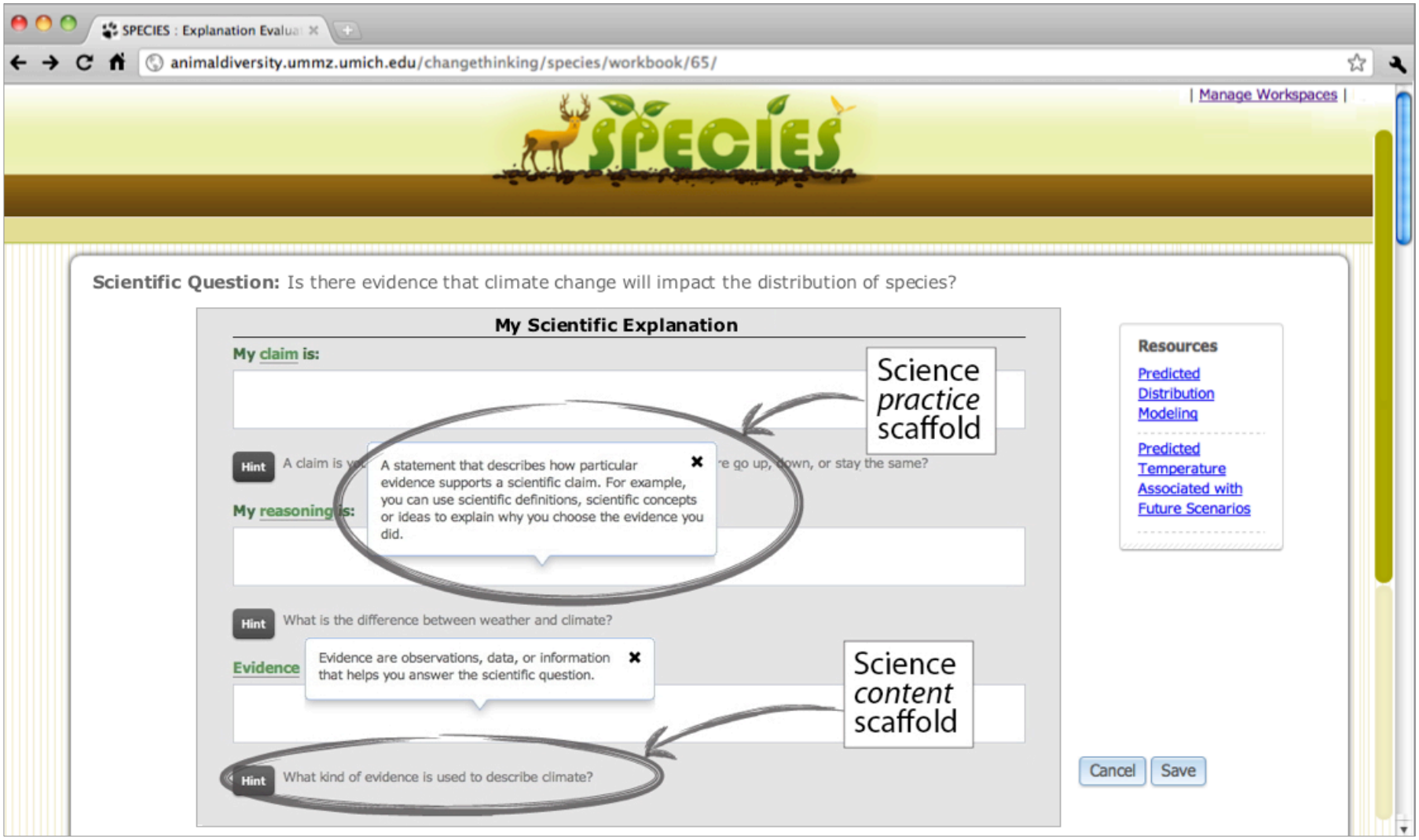


Red Squirrel: Future 3

Focal Species Current and Future Distributions



Is there evidence that climate change will impact the distribtution of species?



Conclusions

- Climate science is a complex, interdisciplinary science; Learning Progressions can **serve as currency** to help us prioritize and share knowledge
- Learning Progressions are essential **templates for the systematic design and evaluation** of higher order, NGSS learning goals (content + practices)
- Creation of LPs requires **deep collaboration** among educator-scientist teams

For More Information

- http://sitemaker.umich.edu/essentialscience/home or
- songer@umich.edu, vlpeters@umich.edu